ECO ENGINEER

NATIONAL SCIENCE FAIR RESEARCH PAPER

LEVEL: SENIOR LEVEL

CATEGORY: LIFE SCIENCE

SUBMITTED BY:

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CLASS XI

FATHIMA CENTRAL SENIOR SECONDARY SCHOOL

ECO ENGINEER

CONTENT

Abstract

Plastic pollution is one of the most serious environmental challenges facing the world today. At the same time, agriculture needs eco-friendly alternatives to chemical fertilizers to meet growing food demands sustainably.

This project explores an innovative biological solution by using superworms (Zophobas morio) to consume plastic waste (polystyrene) and convert it into nutrient-rich frass (insect feces).

The project examines the potential of this frass to act as an organic fertilizer, comparing it with vermicompost on the germination and early growth of mustard, fenugreek, and coriander seeds.

Results showed that seeds grown in superworm frass germinated faster and appeared healthier than those grown in vermicompost, demonstrating that superworm frass can be a sustainable biofertilizer while simultaneously addressing plastic pollution

AIM

To investigate the ability of superworms to biodegrade polystyrene and to evaluate the effectiveness of superworm frass as a natural biofertilizer compared to vermicompost on the germination and early growth of selected seeds.

Introduction

Plastic pollution is a major global environmental concern that demands innovative and sustainable solutions. At the same time, meeting increasing food demands while reducing agriculture's environmental impact is one of the greatest challenges of the twenty-first century.

This Life Science project explores the potential of using superworms (Zophobas morio) as a bioconversion tool to mitigate plastic waste while benefiting agriculture. Superworms are capable of consuming polystyrene (PS) and other plastics without harmful effects, producing nutrient-rich frass (insect feces). This frass may act as an organic fertilizer, enhancing seed germination and plant growth. By integrating plastic waste management and sustainable agriculture, this project contributes to a zero-waste circular economy.

Background: Why Insect Frass?

Insect frass is an emerging organic fertilizer with promising potential for soil enrichment and plant growth. Superworm frass is rich in nutrients and may improve soil fertility, similar to traditional vermicompost. Recent studies have shown that insects like superworms can consume plastics while producing frass that is safe for plants.

This study evaluates superworm frass on the growth of three seed types:

fenugreek, mustard, and coriander, comparing it with standard vermicompost to determine its effectiveness as a natural fertilizer.

Research Question

"Can superworm frass enhance plant growth better than vermicompost?"

Hypothesis

"Seeds germinated and grown in superworm frass will show faster growth, better germination rates, and healthier plants compared to those grown in vermicompost."

Objectives

- **To evaluate the ability of superworms to consume polystyrene (PS) and produce frass.**
- **To study the effect of superworm frass on seed germination and plant growth.**
- **To compare the fertilizer potential of superworm frass with vermicompost.**

Materials Required

- **500 superworms (Zophobas morio)**
- **2 metal containers for rearing worms**
- **Polystyrene bottle powder**
- **Mustard seeds, Fenugreek seeds, Coriander seeds**
- **Vermicompost (control)**
- **12 paper cups/pots**
- **Weighing machine**
- **PH meter**
- **Thermometer**
- **Log notebook**
- **Water**

DESIGN OF STUDY

Independent Variable:

- **Type of fertilizer (superworm frass vs. vermicompost)**

Dependent Variable:

- **Seed germination rate and plant growth**

Controlled Variables:

- **Soil type, soil amount, water, sunlight exposure, seed type, frass/compost quantity, temperature**

Experimental Design and Procedure

A. **Superworm Rearing and Frass Collection**

- **Divide 500 superworms into two metal containers (250 per container).**
- **Feed each container with 15 g of polystyrene (PS) bottle powder.**
- **Check daily the amount of PS eaten and replenish as needed until 50 g of frass is produced.**
- **Collect frass by sieving the container contents to remove uneaten PS and worms.**
- **Maintain worms at ~25°C temperature and ~50% humidity until sufficient frass is collected.**

B. **Seed Growth Experiment**

- **Select fenugreek, mustard, and coriander seeds.**
- **Take 12 paper cups of equal size.**
- **Fill each cup with 5 g of frass:**
- **F9 cups with superworm frass (3 cups per seed type) • 3 cups with vermicompost as control (1 cup per seed type)**
- **Sow seeds in the respective cups.**
- **Label all cups clearly: Control (vermicompost) and Superworm frass.**

- **Place cups under sunlight and sprinkle water daily.**
- **Observe and record**
- **Tabulate observations to compare growth in superworm frass vs.**
  vermicompost.

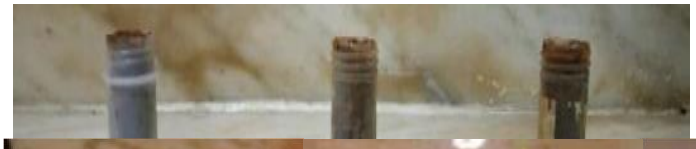
Data Collection:

Photographs:

Super worms:

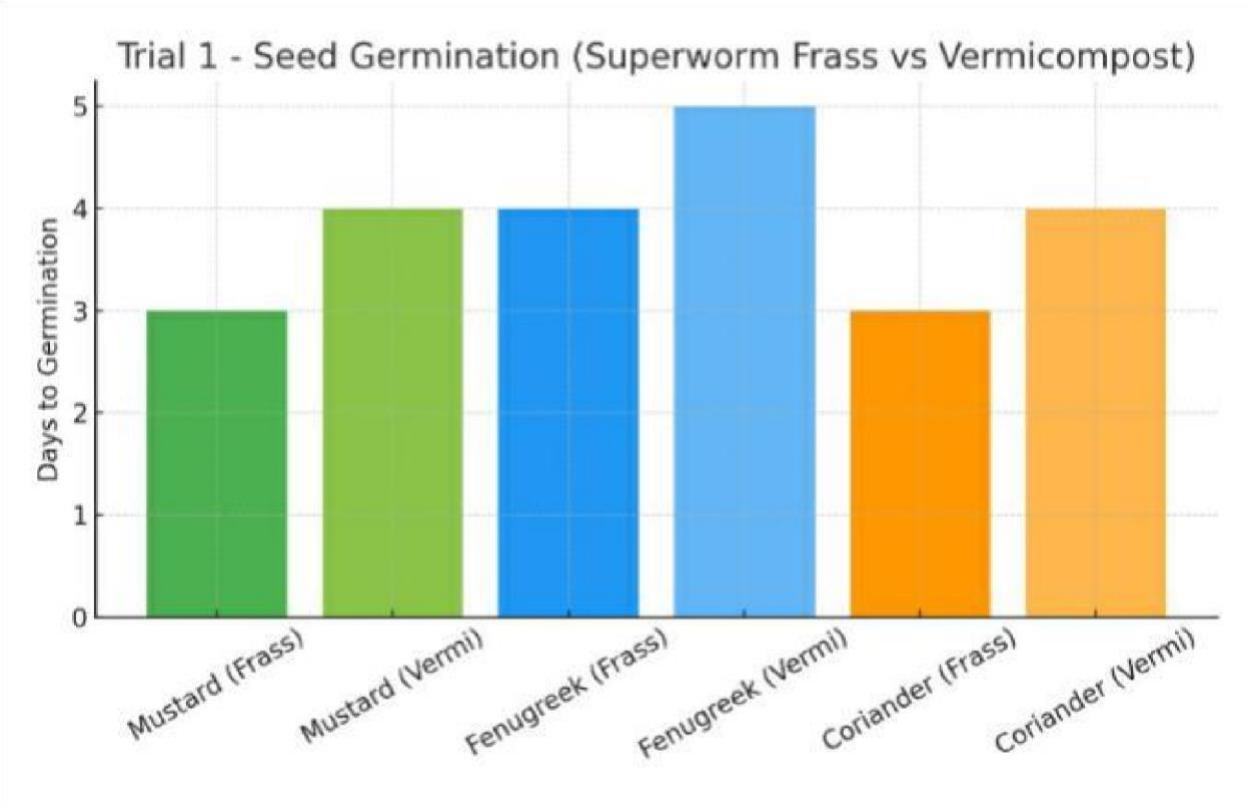
Feeding: **Grass:**

Growth of Plants:



TRIAL 1

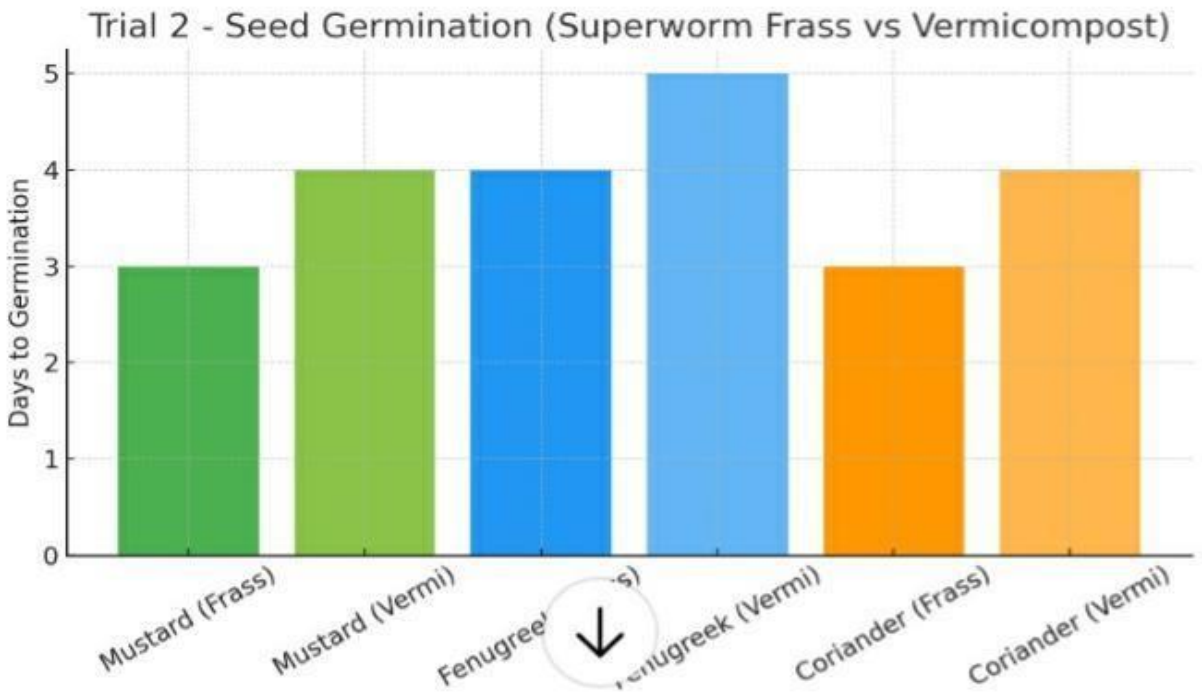
TYPES OF PLANT	TREATMENT	PLANT GERMINATION						
		DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7
MUSTARD SEED	SUPERWORM FRASS	0	0	1	1	1	1	1
	VERMICOMPOST (C)	0	0	0	1	1	1	1
FENUGREEK SEED	SUPERWORM FRASS	0	0	0	1	1	1	1
	VERMICOMPOST (C)	0	0	0	0	1	1	1
CORIANDER SEED	SUPERWORM FRASS	0	0	1	1	1	1	1
	VERMICOMPOST (C)	0	0	0	1	1	1	1



TRIAL 2

TYPES OF PLANT	TREATMENT	PLANT GERMINATION						
		DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7
MUSTARD SEED	SUPERWORM FRASS	0	1	1	1	1	1	1
	VERMICOMPOST (C)	0	0	1	1	1	1	1
FENUGREEK SEED	SUPERWORM FRASS	0	0	1	1	1	1	1
	VERMICOMPOST (C)	0	0	0	1	1	1	1
CORIANDER SEED	SUPERWORM FRASS	0	1	1	1	1	1	1
	VERMICOMPOST	0	0	1	1	1	1	1

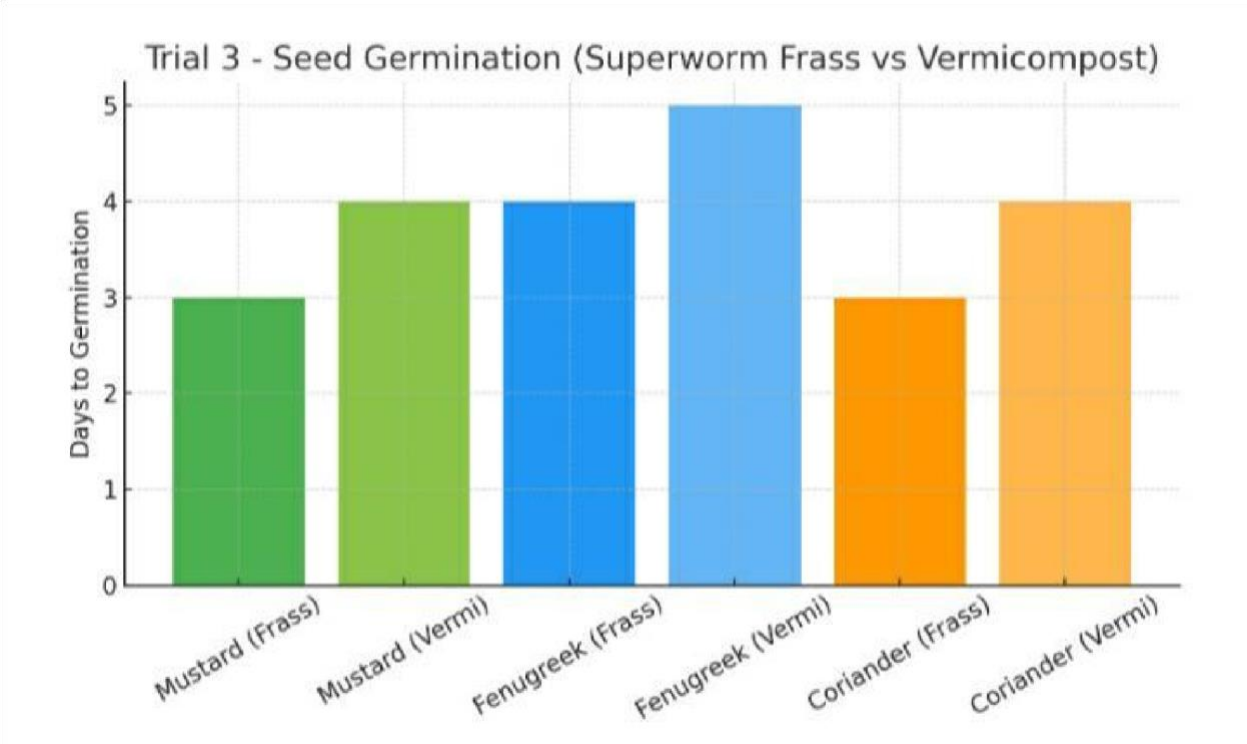
	(C)							



TRIAL 3

TYPES OF PLANT	TREATMENT	PLANT GERMINATION						
		DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7
MUSTARD SEED	SUPERWORM FRASS	0	0	1	1	1	1	1
	VERMICOMPOST (C)	0	0	0	1	1	1	1
FENUGREEK SEED	SUPERWORM FRASS	0	0	0	1	1	1	1

	VERMICOMPOST (C)	**0**	**0**	**0**	**0**	**1**	**1**	**1**
CORIANDER SEED	**SUPERWORM FRASS**	**0**	**0**	**1**	**1**	**1**	**1**	**1**
	VERMICOMPOST (C)	**0**	**0**	**0**	**1**	**1**	**1**	**1**



Result

All seeds germinated successfully under both conditions, but those grown in superworm frass germinated 1 day earlier on average compared to vermicompost.

Plants in frass showed better vigor and leaf color, suggesting higher nutrient availability and microbial activity.

This supports the hypothesis that superworm frass enhances seed germination and early plant growth more effectively than vermicompost.

Conclusion

The study demonstrated that superworms can degrade polystyrene waste and their frass can act as an effective biofertilizer.

Superworm frass improved the germination rate of mustard, fenugreek, and coriander compared to vermicompost.

Thus, this innovative approach provides a dual benefit — reducing plastic pollution and improving soil health through natural means.

Application

- **Plastic waste management through biological conversion by superworms.**

- **Use of frass as an organic fertilizer for sustainable farming.**
- **Educational model for eco-engineering and zero-waste ecosystems.**
- **Reduces dependence on chemical fertilizers.**

Future Enhancement

- **Conduct chemical analysis of frass to determine NPK content.**

- **Test with different types of plastic and insect species.**
- **Measure long-term soil health effects.**
- **Scale-up experiments to larger agricultural fields.**

AKNOWLEDGEMENT

I wish to express my profound gratitude to our Education Director, DR. A NIGAR AKTHAR, for her visionary leadership and for fostering an academically enriching environment that continually motivates students to excel. I am equally greatful to our Principal, MR.NAAZ PARWAR, whose constant support, encouragement, and provision of necessary resources have enabled the smooth execution of this project. Their dedication to educational excellence has been a source of great inspiration.

I extend my sincere appreciation to my Guide Teacher, MRS. FOUZIA BEE N , for her scholarly guidance, thoughtful suggestions, and

consistent mentorship throughout the development of this work. Her critical insights and academic support have significantly contributed to the clarity, depth, and quality of this project, and I remain deeply indebted to her.

I also convey my heartfelt thanks to my parents and friends, whose encouragement, cooperation, and assistance have been invaluable during various stages of this research. Their unwavering support has played a crucial role in the successful completion of this project.

References

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